PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
D01D 5/253, 5/24

A1

(11) International Publication Number: WO 99/39029

(43) International Publication Date: 5 August 1999 (05.08.99)

(21) International Application Number: PCT/US99/00647

(22) International Filing Date: 11 January 1999 (11.01.99)

(30) Priority Data:
09/016,384 30 January 1998 (30.01.98) US

(71) Applicant: E.I. DU PONT DE NEMOURS AND COMPANY [US/US]; 1007 Market Street, Wilmington, DE 19898 (US).

(72) Inventor: LIN, Perry, Han–Cheng; 5318 Grand Harbour Drive, Hixson, TN 37343 (US).

(74) Agent: MEDWICK, George, M.; E.I. du Pont de Nemours and Company, Legal Patent Records Center, 1007 Market Street, Wilmington, DE 19898 (US).

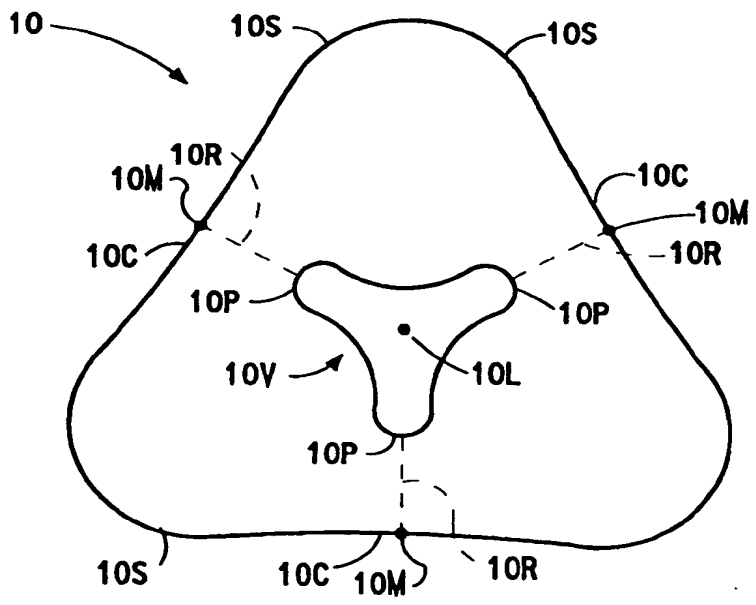
(81) Designated States: AU, CA, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: FILAMENT HAVING A TRILOBAL CROSS SECTION AND A TRILOBAL VOID

(57) Abstract

A synthetic polymer filament is characterized by a trilobal void that extends centrally and axially through the filament. Each apex of the void extends toward the approximate midpoint of one side of the exterior configuration of the filament. The trilobal void has a modification ratio in the range from about 1.4 to about 3.0 and occupies from about five percent (5 %) to about thirty percent (30 %) of the cross–sectional area of the filament. At a given constant void percentage a decrease of modification ratio increases the degree of sparkle. A spinneret plate for producing the thermoplastic synthetic polymer filament has a cluster of three generally arrow–shaped orifices centered about a central point. Each orifice is defined by a first and a second outer leg joined together at a pointed end directed away from a central point of the cluster. Each orifice has a central leg extending from the jointure of the outer legs toward the central point of the cluster. Each outer leg has a free end thereon which is spaced from the free end of an outer leg of an adjacent orifice to define a gap therebetween.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

TITLE

FILAMENT HAVING A TRILOBAL CROSS-SECTION AND A TRILOBAL VOID

Background of the Invention

Field of the Invention The present invention relates to a generally trilobal filament having a central axial trilobal void useful as carpet yarn having high "glitter", excellent durability, and good soiling resistance and, to a spinneret plate for producing the filament.

Description of the Prior Art The term "glitter", when describing a filament used to form a carpet yarn, is a characteristic of the luster of the yarn and refers to the shiny appearance of a yarn when light is reflected by it. A yarn having a high glitter is also synonymously described in the art as having a "metallic" luster or a high degree of "sparkle".

Recently, carpet yarn having levels of glitter higher than those used in the past have become fashionable. Accordingly, it is believed desirable to provide a filament useful in forming a carpet yarn that exhibits a high degree of glitter.

Summary of the Invention

The present invention is directed to a thermoplastic synthetic polymer filament which, due to its high glitter, excellent durability, and good soiling resistance, is believed to be especially useful as carpet yarn. The filament of the present invention has an exterior configuration having three sides and an exterior modification ratio from about 1.4 to about 2.3 and a trilobal void extending centrally and axially therethrough. Each apex of the void extends toward the approximate midpoint of one side of the exterior

configuration of the filament. The trilobal void has a modification ratio in the range from about 1.4 to about 3.0 and occupies from about five percent (5%) to about thirty percent (30%) of the cross sectional area of the filament. At a given constant void percentage a decrease of modification ratio increases the degree of glitter.

In another aspect the present invention is directed to a spinneret plate for producing the thermoplastic synthetic polymer filament as above described. The spinneret plate has a cluster of three generally arrow-shaped orifices centered about a central point. Each arrow-shaped orifice is defined by a first and a second outer leg joined together at a pointed end. The pointed end of each arrow-shaped orifice is directed away from the central point of the cluster. Each arrow-shaped orifice has a central leg extending from the jointure of the outer legs toward the central point of the cluster. Each outer leg has a free end thereon. The free end of an outer leg of each arrow-shaped orifice is spaced from the free end of an outer leg of an adjacent orifice to define a gap therebetween. The gaps are positioned such that an extension of the central leg of each arrow-shaped orifice passes through a gap defined between the legs of the other arrow-shaped orifices.

Brief Description of the Drawings

The invention will be more fully understood from the following detailed description, taken in connection with the accompanying drawings, which form a part of this application and in which:

Figure 1 is a cross section view of a filament in accordance with the present invention as produced in Example 1 hereof;

Figure 2 is a view of the bottom surface of a spinneret plate having a cluster of apertures forming

therein for producing the filament shown in Figures 1 and 3; and

Figure 3 is a cross section view of a filament in accordance with the present invention as produced in Example 2 hereof.

Detailed Description of the Invention

Throughout the following detailed description similar reference numerals refer to similar elements in all Figures of the drawings.

Figures 1 and 3 are cross section views of a thermoplastic synthetic polymer filament generally indicated by the characters 10, 10', each in accordance with the present invention. Generally speaking, the filament 10, 10' in accordance with the present invention has a three-sided exterior configuration and has an exterior modification ratio in the range from about 1.4 to about 2.3. It is specifically noted that such an exterior configuration encompasses so-called triangular (delta)-shaped as well as trilobal configurations. It should also be noted that an increased modification ratio of the exterior of the filament may result in increased soilability.

More particularly, the filament 10, 10' as respectively illustrated in Figures 1 and 3 may be characterized as having an exterior configuration that is substantially equilaterally triangular in axial cross-section, with each side 10S, 10'S of the filament 10, 10', respectively having a slight concavity 10C, 10'C formed therein. Each concavity 10C, 10'C lies approximately midway along a side 10S, 10'S of the exterior configuration of the filament 10, 10'.

The filament 10, 10' has a trilobal void 10V, 10'V extending centrally and axially therethrough. The trilobal void 10V, 10'V has a modification ratio (MR) in the range from about 1.4 to about 3.0. The void 10V occupies from about five percent (5%) of the cross sectional area of the filament 10 to about thirty

percent (30%) of the cross sectional area of the filament 10. The void 10V in Figure 1 occupies about six percent (6%) of the cross sectional area of the filament 10, while the void 10'V as illustrated in Figure 3) occupies about eighteen percent (18%) of the cross sectional area of the filament 10'.

In accordance with the present invention the central void 10V, 10'V is positioned with respect to the central axis 10L, 10'L of the filaments 10, 10' such that each apex 10P, 10'P of the void 10V, 10'V extends toward the concavity 10C, 10'C of the proximal side of the exterior configuration of the filament. As indicated in Figures 1 and 3 each apex 10P, 10'P of the void 10V, 10'V is generally radially aligned (along the reference line 10R, 10'R) with the midpoint 10M, 10'M of each side of the exterior configuration of the filament 10, 10'.

A filament in accordance with the present invention may be prepared using a synthetic, linear, thermoplastic melt-spinnable polymers, including among these polyamides, polyesters, and polyolefins. After melting the polymer is extruded ("spun") through a spinneret plate 20 (to be described hereinafter) under conditions which vary depending upon the individual polymer and the particular filament being spun thereby to produce a filament having a desired denier and a desired void percentage. Void percentage can be increased by a more rapid quenching and increasing the melt viscosity, which can slow the flow allowing sturdy, pronounced molding to occur.

The present invention is also directed to a spinneret plate 20 for producing the filament depicted in Figures 1 and 3. A view of the bottom surface 20B of the spinneret plate 20 is shown in Figure 2.

As is known in the art a spinneret plate 20 is a relatively massive member having an upper surface and a bottom surface 20B. A portion of the upper surface of the spinneret plate is provided with a bore recess

whereby connection of the plate 20 to a source of polymer may be effected. Depending upon the rheology of the polymer being used the lower margins of the recess may be inclined to facilitate flow of polymer from the supply to the spinneret plate. If provided, a typical angle of inclination is on the order of about one hundred fifty degrees (150°).

A capillary generally indicated by the reference character 24 extends through the plate 20 from the recessed upper surface to the bottom surface 20B. As is seen in Figure 2 the capillary 24 is defined by a cluster of three generally arrow-shaped orifices 24A, 24B, and 24C. The orifices 24A, 24B, and 24C are centered about a central point P. Each arrow-shaped orifice is defined by a first and a second outer leg 24L-1, 24L-2 that are joined together to form a pointed end 24P. Each pointed end 24P of each arrow-shaped orifice is directed away from the central point P of the cluster. Each arrow-shaped orifice has a central leg 24L-3 extending from the jointure of the outer legs 24L-1, 24L-2 toward the central point P of the cluster.

Each outer leg 24L-1, 24L-2 has a free end 24F. The free end 24F of each outer leg of each arrow-shaped orifice is spaced from the free end of an outer leg of an adjacent orifice to define a gap 24G therebetween. The gaps 24G are positioned such that an extension 24E of the central leg 24L-3 of each arrow-shaped orifice 24A, 24B, or 24C passes through a gap 24G defined between the legs of the other two arrow-shaped orifices.

The various above-defined features of the capillary 24 that open onto the bottom surface 20B of the spinneret plate 20 are defined by parallel surfaces that extend from the bottom surface 24B for at least a portion of the way through the thickness of the plate. This distance is usually termed in the art as the "cap depth". The parallel surfaces are spaced from each

other by a dimension known in the art as the "slot width". In the production of a polyamide filament the surfaces defining the apertures of the capillary extend in parallel relationship completely through the thickness of the plate 20. For filaments made of other materials, such as polypropylene, it sometimes preferred (for considerations relating to the spinning process) that the parallel surfaces extend over only a predetermined portion of the thickness distance from the lower to the surface of the recess in the spinneret plate. Over the remaining portion of this thickness of the plate the surfaces defining the apertures incline outwardly from the axis of the aperture at an angle of inclination on the order of about fifty degrees (50°). The overall dimension of the slot (perpendicular to the bottom surface 20B) is usually referred to in the art as the "slot depth". The slot depth is understood to include both the parallel portion of the slot and the tapered portion of the slot.

The spinneret plate may be fabricated using the laser technique disclosed in United States Patent 5,168,143, (Kobsa et al., QP-4171-A) assigned to the assignee of the present invention.

Example 1

Using a spinneret plate having a capillary 24 with a cap depth of 0.0150 inches (with no tapered portion), a bore recess diameter in the upper surface of 0.1360 inches, and having the following dimensions for the various portions of each of the spinneret apertures as indicated by the corresponding reference characters on Figure 2:

D (dimension) = 0.0791",
E (slot width, legs 24L-1, 24L-2) = 0.0110",
F (slot width, central leg 24L-3) = 0.0085",
G (dimension) = 0.0070", and
H (dimension) = 0.0075",

nylon 6,6 polymer of temperature 286°C was spun at a

throughput of 326 gram/min. Ninety (90) filaments were then drawn through a quenching chimney having a quench airflow between 250 to 350 CFM. This drawing was done by a feed roll of speed 768 ypm which, in turn, was drawn again by the draw rolls rotating at 2063 ypm; (a draw ratio of 2.7). The draw roll temperature was 225°C. Next, a bulking jet at 240°C, 120 psi crimped the heated filaments before they moved onto the perforated surface of a bulking drum rotating at 65 rpm inside a bulking chest. Finally, the filaments were taken by a pair of take-up rolls and wound onto the winders rotating at 1891 ypm.

A filament 10 having a cross-section as shown in Figure 1 and an exterior modification ratio of about 1.8 was thereby produced, the filament having a 6.3% void percentage and a void modification ratio of 2.2. The filaments were tufted to form a loop pile carpet construction. The carpet was dyed to medium blue.

The carpet produced using the filament formed in the manner described was compared for glitter with two carpet samples formed from two trilobal cross section yarn having three and six voids, (Comparative samples A and B, respectively) and to a carpet formed from a square filament having four voids (Comparative sample C). The results are as tabulated in the following Table.

The glitter value in the Table was measured by ten viewers on a scale of "1" to "5", with a value of "5" being the most glitter. The rating for each sample was averaged to produce the value in the Table.

Table

	Ex.1	Comp.Ex. A	Comp.Ex. B	Comp.Ex. C
Glitter	5	1.7	1.0	1.6

It is also believed that for a given void percentage a filament exhibits increasing sparkle for decreasing modification ratio of the void.

Note: Comparative Examples A and B are as described in United States Patent 5,523,155 (Lin et al., RD-6965). Comparative Example C is as described in United States Patent 5,190,821 (Goodall et al., RD-5865).

Example 2

Using the same spinneret plate as was used to produce Example 1, polypropylene polymer of temperature 255°C was spun at a throughput of 303 grams/minute. The filaments were then drawn through a quenching chimney having a quench airflow of 350 CFM. This drawing was done by a feed roll of speed 655 ypm which, in turn, was drawn again by the draw rolls rotating at 1611 ypm; a draw ratio of 2.5. The draw roll temperature was 135°C. Next, a bulking jet at 160°C, 110 psi crimped the heated filaments before they moved onto the perforated surface of the bulking drum rotating at 50 rpm inside a bulking chest. Finally, the filaments were taken by a pair of take-up rolls and wound onto the winders.

A filament 10' having a cross-section as shown in Figure 3 and an exterior modification ratio of about 1.5 was thereby produced, the filament having a 17.6% void percentage and a void modification ratio of 3.0

Those skilled in the art, having the teachings of the present invention as hereinbefore set forth may effect numerous modifications thereto. It should be appreciated that such modifications are to be construed within the contemplation of the present invention, as defined by the appended claims.

What is claimed is:

1. A thermoplastic synthetic polymer filament having an exterior configuration having three sides thereon and an exterior modification ratio in the range from about 1.4 to about 2.3,

the filament having a trilobal void extending centrally and axially therethrough, each apex of the void extending toward the approximate midpoint of one side of the exterior of the filament, the trilobal void having a modification ratio in the range from about 1.4 to about 3.0, the void occupying from about five percent (5%) to about thirty percent (30%) of the cross sectional area of the filament.

2. A spinneret plate for producing a thermoplastic synthetic polymer filament having an exterior configuration having three sides and a trilobal void extending centrally and axially therethrough,

the spinneret plate having a cluster of three generally arrow-shaped orifices centered about a central point, each arrow-shaped orifice being defined by a first and a second outer leg joined together at a pointed end, the pointed end of each arrow-shaped orifice being directed away from the central point of the cluster, each arrow-shaped orifice having a central leg extending from the jointure of the outer legs toward the central point of the cluster,

each outer leg having a free end thereon, the free ends of an outer leg of each arrow-shaped orifice being spaced from the free end of an outer leg of an adjacent orifice to define a gap therebetween, an extension of the central leg of each arrow-shaped orifice extending through a gap defined between the legs of the other arrow-shaped orifices.

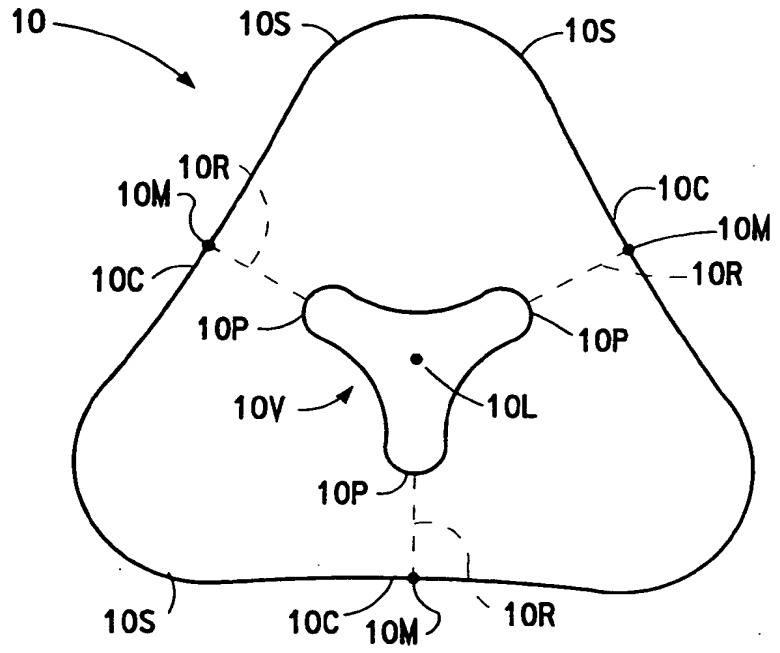

10
10S
10S
10R
10M
10C
10M
10C
10R
10P
10P
10V
10L
10P
10S
10C
10M
10R

FIG. 1

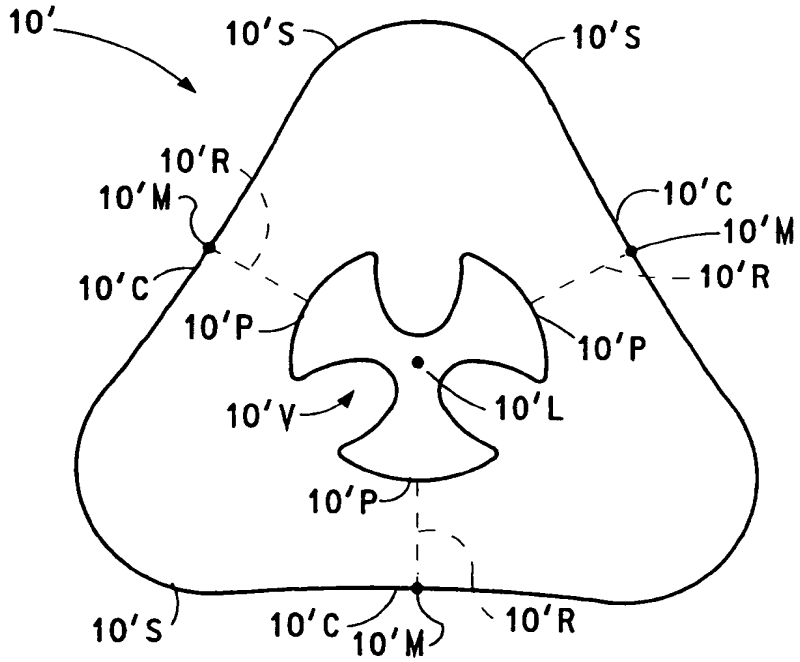

10'
10'S
10'S
10'R
10'M
10'C
10'M
10'C
10'R
10'P
10'P
10'V
10'L
10'P
10'S
10'C
10'M
10'R

FIG. 3

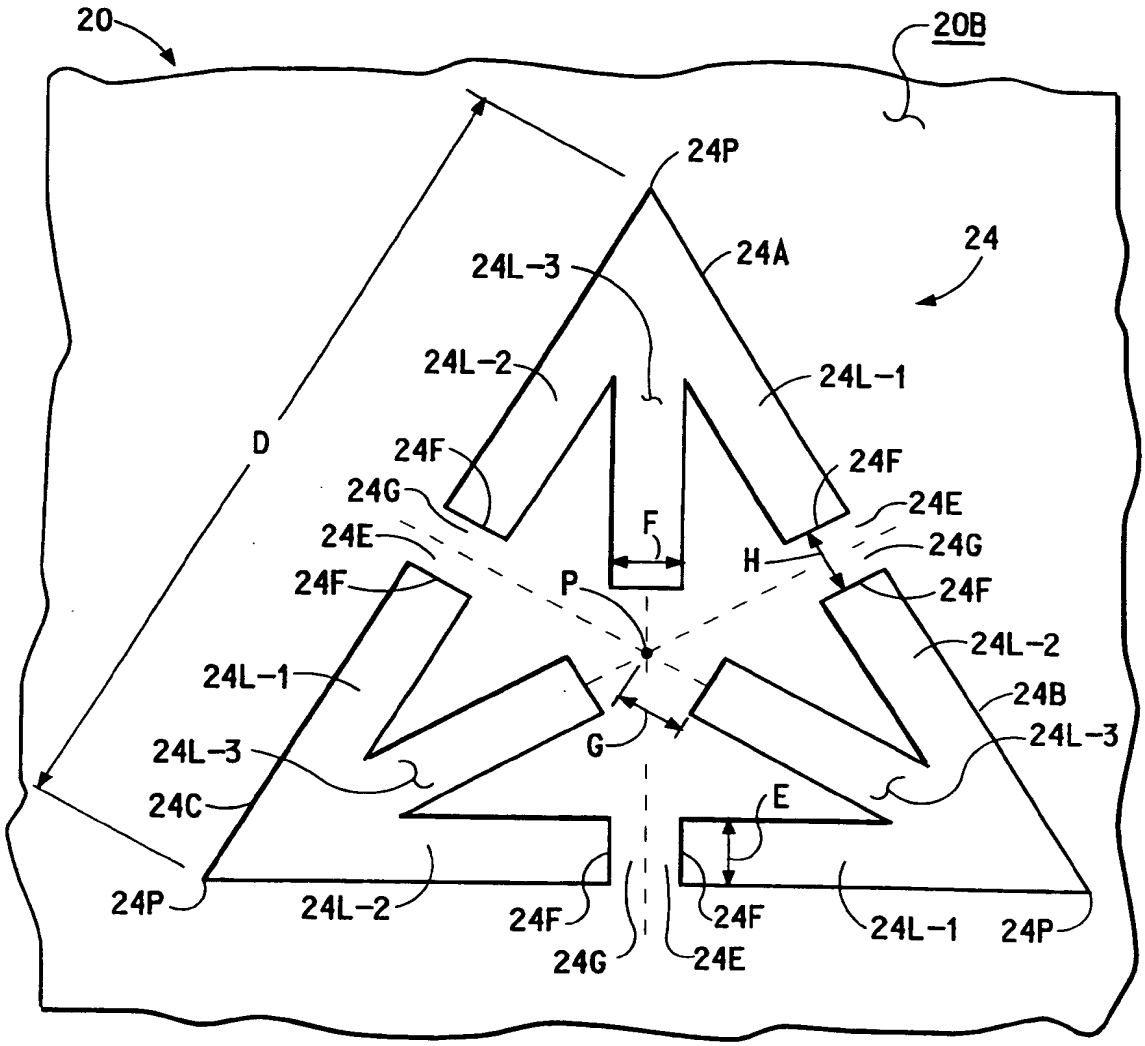


FIG. 2

INTERNATIONAL SEARCH REPORT

Int. .onal Application No
PCT/US 99/00647

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D01D5/253 D01D5/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 07 238419 A (TORAY IND INC) 12 September 1995 see figures 2B,3B & PATENT ABSTRACTS OF JAPAN vol. 96, no. 1, 31 January 1996 & JP 07 238419 A (TORAY IND INC), 12 September 1995 see abstract	1,2
A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 012, 25 December 1997 & JP 09 217225 A (TORAY IND INC), 19 August 1997 see abstract	1,2
A	EP 0 016 450 A (TEIJIN LTD) 1 October 1980 see claims 1,4; figures 1R,1S,2R,2S	1,2

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 April 1999	07/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tarrida Torrell, J

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 99/00647

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 329 553 A (SIMS J G ET AL) 4 July 1967 see claims; figure 5	1,2
A	US 3 528 128 A (MURAKAMI SHOICHI ET AL) 15 September 1970 see the whole document	1,2
A	US 2 939 201 A (HOLLAND M C) 7 June 1960 see the whole document	1,2

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte onal Application No
PCT/US 99/00647

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 07238419 A	12-09-1995	NONE	
EP 0016450 A	01-10-1980	JP 56107044 A	25-08-1981
		JP 56107045 A	25-08-1981
		JP 56112568 A	04-09-1981
		JP 55128044 A	03-10-1980
		JP 1414051 C	10-12-1987
		JP 56031073 A	28-03-1981
		JP 62021902 B	14-05-1987
		JP 1351322 C	28-11-1986
		JP 56049070 A	02-05-1981
		JP 61015178 B	23-04-1986
		JP 56058067 A	20-05-1981
		CA 1138630 A	04-01-1983
		US 4316924 A	23-02-1982
		US 4332585 A	01-06-1982
US 3329553 A	04-07-1967	NONE	
US 3528128 A	15-09-1970	BE 703344 A	15-01-1968
		DE 1660660 A	28-10-1971
		GB 1167622 A	15-10-1969
US 2939201 A	07-06-1960	NONE	